

# QUESTIONS AND ANSWERS ABOUT ETHANOL

**ethanol**  
Fuel For Clean Air

## A Note To Our Readers

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This booklet contains a summary of the questions most often asked by consumers, mechanics, policy makers and others throughout the state as our Minnesota Ethanol Program was being developed.

**The primary components of Minnesota's ethanol program are:**

- The state wide oxygenated fuel requirement that resulted in about 10% of the state's gasoline being replaced by domestic renewable ethanol.
- Fifteen ethanol plants, mostly New Generation Farmer Cooperatives, will produce the ethanol required to clean up our gasoline.

We are proud that this program reduces our annual cost of imported oil by over \$100 million, provides over \$350 million net annual economic benefit to the states economy and provides Minnesota corn farmers with benefits from the processing of 80 million bushels of our largest crop.

As the program developed over the years, we were confronted with a variety of economic and policy questions and many claims about problems ethanol fuels would create. Our Ethanol Hot Line was established and has been open to the public since 1992. We answer all Hot Line calls on a personal basis and follow up on the problems expressed. Because of these activities we learned a great deal about gasoline storage and handling, materials compatibility and engine performance. Today, virtually all gasoline in Minnesota contains ethanol and consumers are generally enjoying great performance in all types of gasoline engines, new and old.

We hope that the information presented in this booklet will put many aspects of the ethanol issue in perspective for you and also help to answer your questions about ethanol fuels.

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## Ethanol Use in Automotive Engines

### 1. Will the use of ethanol void my car's warranty?

*Certainly not!* When the use of ethanol began in 1979, most automobile manufacturers did not even address alcohol fuels. As soon as each manufacturer tested their vehicles, they approved the use of a 10% ethanol blend. Today, all manufacturers approve the use of ethanol, and some even recommend ethanol use for environmental reasons. Many manufacturers do recommend against the use of methanol (wood alcohol).

### 2. Will ethanol work in fuel-injected engines?

*Absolutely!* Ethanol never contributed to burning or fouling of port fuel injectors. Fuel injectors are manufactured to very exact tolerances, so it takes a very small amount of deposits to affect the efficiency of an injector. Components of gasoline, such as olefins, have been identified as causing deposits that result in fouled injectors. Since 1985, all ethanol blends and nearly all non-ethanol gasolines have contained corrosion inhibitors and detergent additives that are designed to prevent injector deposits. These detergents have been very effective in alleviating this gasoline problem.

### 3. If I use ethanol, do I need a gas line anti-freeze?

*No!* Gas line anti-freeze is alcohol - usually methanol, ethanol, or isopropyl, which may be used up to a .3% level in your car's fuel tank. All alcohols have the ability to absorb water, and therefore condensation in the fuel system is absorbed and does not have the opportunity to collect and freeze. Since an ethanol blend contains up to 10% ethanol, it is able to absorb more water than a small bottle of methyl or isopropyl alcohol, therefore eliminating the need and expense of adding a gas line anti-freeze.

### 4. Won't ethanol burn valves?

Ethanol will not burn valves. Ethanol burns cooler than gasoline. Many high-powered racing engines use pure alcohol for that reason.

### 5. Will ethanol hurt my older engine designed for leaded gas?

*No.* The concern about older engines came about because of the lead phase-out. Lead oxides that were formed during combustion provided a cushion that reduced wear on non-case-hardened "popet" style valve seats. Therefore, it is the absence of lead, not the presence of ethanol, that is of concern.

## **6. Does ethanol lead to plugged fuel filters?**

Ethanol can loosen contaminants and residues that have been deposited by previous gasoline fills. These can collect in the fuel filter. This problem has happened occasionally in older cars, and can easily be corrected by changing fuel filters. Symptoms of a plugged fuel filter will be hesitation, missing, and a loss of power. Once your car's fuel system is clean, you may note improved performance.

## **7. Why do some mechanics say not to use ethanol?**

A mechanic who says not to use ethanol does not have correct information. About the only thing most people (including many mechanics) know about gasoline is that some of it is blended with ethanol. When there appears to be a fuel-related problem with an engine, some mechanics will immediately ask if ethanol has been used. One reason ethanol is suspected is that in many states it is the only gasoline component that requires an identifying label.

## **8. Do we still need leaded gasoline? Why not?**

The availability of tetra-ethyl lead in gasoline is prohibited by federal law. There are additives available to replace the "cushion" value of lead-oxide for older engines with non-hardened "popet" style valve systems. A lead replacement may only be necessary when such an engine is operated under heavy load or very high speed conditions.

## **9. Can ethanol be used in diesel engines?**

Ethanol alone does not mix well with diesel fuel but 300 busses in Stockholm, Sweden are currently running on pure ethanol. Ethanol combined with a special additive is being tested in a blend with diesel fuel in Chicago busses. Preliminary data on this blend indicates significant reductions in particulate matter and carbon monoxide. Improvements in cold weather starting characteristics have also been observed when this new product is combined with petroleum diesel fuel.

## **Use in Two- and Four- Cycle Engines**

### **10. Can I use ethanol in my ATV and chainsaw?**

Yes. An ethanol blend may be used anywhere that unleaded gasoline is used. Nationwide there are farmers, cities, counties, and rural electric co-op fleets, plus snowmobile racers, fishing guides and virtually everybody in Minnesota using ethanol blends exclusively with no performance problems.

### **11. If ethanol can be used in outboard motors, why do some of the owners manuals say not to use it?**

When these cautionary statements were first put in the owners manuals, there was confusion with methanol, and also a concern about the quality control of ethanol, which was produced by a brand-new and rapidly growing industry. Since boats are usually in close proximity to water and often stored outside, there was concern about "phase separation" if the fuel was contaminated with excessive water. All marine motor manufacturers now approve the use of 10% ethanol blend.

### **12. What testing has been done with ethanol in small engines?**

A number of tests have been done. One of them was done at the Lake Area Vo-Tech at Watertown, South Dakota; where they put a lifetime of use on seven different models of small utility equipment. They acquired matched sets of each of the seven models, and ran one on an ethanol blend and the other on an unleaded gasoline. After each test, each motor was torn down for laboratory analysis. The most significant difference was that the ethanol blend engines had slightly fewer carbon deposits. The Detroit Lakes Technical College at Detroit Lakes, Minnesota studied the "Hydroscopic effects of a marine environment on ethanol blended gasoline", and concluded that the amount of water an ethanol blend will absorb from the atmosphere is minimal, and should not be a concern.

### **13. What is phase separation?**

When a 10% ethanol blend is contaminated with over .5% water, the ethanol and water mixture will separate from the gasoline and fall to the bottom of the gas tank. This is an inconvenience, because the fuel system must then be drained and new fuel added. Before using ethanol-blended fuel for the first time in an older small engine, it is recommended that all water be removed from the tank. Since many outboard motor carburetor problems result from water in the fuel system, continuous use of an ethanol blend can prevent water accumulation and unnecessary maintenance.

#### **14. Will two-cycle oil separate from an ethanol-blended gasoline?**

No, once properly mixed, all approved two-cycle oils will remain in solution with an ethanol-blended gasoline.

#### **15. Does ethanol make gasoline go bad in storage?**

No! Storage problems are primarily caused by the storage conditions and the chemical composition of the gasoline itself. Whether you use ethanol blends or not, avoid carrying gasoline over from one season to the next. Don't fill a storage tank at the end of the season. Try to run the tank dry in your seasonal equipment before it is time for storage. If this is not practical, store your gasoline according to the recommendations in the "Storing Gasoline" factsheet on page 22 and 23.

## **The Economics of Ethanol**

#### **16. Is ethanol-blended gasoline more costly than petroleum gasoline?**

No! Ethanol-blended gasoline is generally available to marketers at a lower cost than petroleum gasoline (petro-gas) of the same octane. After the federal ethanol tax credit is applied, the cost of ethanol to marketers is about the same as Regular Unleaded gasoline and often less. Ethanol is relatively inexpensive to blenders and can increase the octane value of gasoline considerably.

Octane is a measure of gasoline's resistance to burn prematurely under high compression causing an engine to "knock" or "ping" under load. For many years gasoline quality, and therefore its price, has been expressed in terms of its octane or "anti knock" rating. "The higher the octane the higher the price." In some markets ethanol is found only in high octane (higher priced) gasoline. This made some people think ethanol blends were more expensive.

In most markets the standard grade of gasoline "regular unleaded" has an octane rating of 87. Mid-grade gasoline sometimes called "Unleaded Plus" (89 to 90 octane) and Premium (91 or higher octane) are usually offered at wholesale and retail outlets for a higher price than Regular Unleaded. The wholesale price per gallon of Unleaded Plus (89-90 octane) gasoline may be 3¢ to 5¢ higher than Regular Unleaded (87 octane). Premium gasoline (91 octane) at may be priced 3¢ to 5¢ higher than Unleaded Plus.

The standard "blending octane value" for ethanol is about 113. Normally one gallon of ethanol blended with 9 gallons of petro-gas raises the octane of the 10- gallon blend to the next grade level. For instance after blending 9 gallons of petro-gas with one gallon of ethanol, Regular Unleaded (87 octane) becomes Unleaded Plus (89-90 octane) and Unleaded Plus becomes Premium (91+ octane). Consequently, marketers can often buy 89-90 octane Unleaded Plus ethanol blended gasoline for the same price, or

less than they would have to pay for 87 octane Regular Unleaded petro-gas.

In order to produce Regular Unleaded gasoline with ethanol, a blender must have access to an 84.5 octane (or "sub-octane") grade of petro-gas. In some markets sub octane gasoline is not made available to blenders. In these locations, Regular Unleaded (the lowest price grade gasoline with the highest sales volume) does not contain ethanol. In markets where sub octane gasoline is available, however, ethanol blended Regular is usually less costly than petro-gas Regular.

The factors discussed above may not be apparent to consumers or even to some retailers. But contrary to a common rumor, ethanol blended gasoline (where available) is almost always less costly than petro-gas of the same octane.

#### **17. If the price of corn goes up, will ethanol become non-competitive with gasoline?**

Corn prices and oil prices can be volatile. Periods when corn prices drove ethanol prices significantly higher than gasoline have been very short and rare. Distillers grains and gluten feed are high-protein feeds that are the co-products remaining when the starch portion of the corn kernel is made into ethanol. Therefore, when the price of corn is high, a greater portion of the processors' costs can be recovered through the sale of protein feeds. Unusual factors, such as drought or flood, could have short-term implications for the ethanol industry.

#### **18. Will ethanol ever be produced as cheaply as gasoline?**

Yes, but ethanol should be compared with other high octane components of gasoline, rather than with gasoline as a whole. In fact, technology is constantly reducing the environmental and monetary cost of ethanol production. Since ethanol reduces exhaust emissions from cars, and is a domestically produced, renewable fuel it provides benefits that gasoline never can. According to recent studies the petroleum industry has enjoyed many years of large tax breaks and subsidies. Studies also suggest that costs of air and water pollution and of our military presence in the Persian Gulf should be attributed to the overall cost of gasoline. On the other hand, corn and ethanol production are becoming more efficient and less energy intensive each year. When the conversion of cellulose to ethanol is perfected the cost of ethanol production is expected to decline drastically. Perennial fiber crops and solid waste will then be used to produce ethanol.

#### **19. How much will the use of ethanol help the price of corn?**

There have been numerous studies done on this issue, and the consensus is that the price of corn will increase from 4¢ to 6¢ per bushel for every 100 million bushels of corn used. The ethanol industry uses about 600 million bushels of corn, or about 7% of our annual corn crop. Price response will vary according to crop prospects, carry-over levels and global supply and demand.

## **20. Shouldn't we be using our corn for food instead of fuel?**

The U.S. historically has a surplus of corn, as much as five billion bushels in 1988. Today, many farmers are loosing their businesses because large surpluses lead to low crop prices. World hunger is more the result of politics and policies, than a shortage of food. In ethanol production only the starch portion of the kernel is converted to ethanol. What remains is all of the vitamins, minerals, protein, and fiber, along with high energy corn oil. Much of the world's population suffers from protein and vitamin deficiencies. Many people suffer from hunger not because there isn't enough food, but because of economic, political and transportation barriers. The development of renewable energy sources like ethanol can make energy more available to remote areas of the world. That should make it easier to get food to isolated people.

## **Ethanol as Part of Public Policy**

### **21. How much of our ethanol is imported?**

There is currently a limit of about 7% of our total ethanol supply that is allowed to come into this country duty-free. The actual amount imported is much less than 7%. The U.S. has generally been a net exporter of fuel ethanol.

### **22. How much of our oil is imported?**

The U.S. Department of Energy calculates that over 54% of our oil was imported in 1998 and that imports will likely rise even higher in the future. A 1995 USDA study stated that, since most ethanol plants are operated on coal and natural gas, one gallon of ethanol can actually replace seven gallons of imported crude oil.

### **23. I have heard that ethanol subsidies deplete the highway trust fund. How can that be justified?**

As of January 1, 2000, Ethanol blends are exempt from 5.3¢ of the 18.3¢ federal gasoline tax. This does reduce the amount of tax collected, but does not reduce the amount that is allocated for the building and maintenance of roads, since the Highway Trust Fund has an increasing surplus of, now, more than \$20 billion. Congress has realized the benefits of ethanol to agriculture, the environment, and to our energy security, and determined that a tax exemption for ethanol blends is the simplest and most effective way to ensure the continued development of a domestic ethanol industry.

## **24. Why does the national media seem to refer to methanol more often than ethanol?**

Methanol has been used as a racing fuel for many years. Methanol is made from natural gas which is mined from ancient deposits like coal and oil. The methanol industry is larger, older and better established than the ethanol industry, which gives it the experience, the political clout, and the budget to generate more news items. In addition, methanol has not been subject to the same misinformation campaign which masked ethanol's many benefits.

## **25. Have there been efforts to mandate the use of ethanol?**

In addition to the Clean Air Act Amendments of 1990, Denver, Phoenix, Albuquerque, and Las Vegas are cities that have successfully mandated the use of oxygenated fuel to help solve their carbon monoxide problems. Much of that market is using ethanol blends, which contain up to 3.5% oxygen. Minnesota is the first state to require the use of oxygenates in virtually all gasoline. Ethanol has been the only oxygenate used in the Minnesota market.

## **26. Do some states encourage the development of an ethanol industry? Does Minnesota?**

Many states have individual state tax exemptions for ethanol blends or financial incentives for the ethanol industry, or a combination of both. Minnesota no longer provides any state tax exemption for ethanol blends but does provide a producer payment of 20¢ per gallon to Minnesota producers who make ethanol from agricultural products. This program has helped to build an ethanol processing industry in the state. Nebraska, South Dakota, and Missouri have followed Minnesota's lead, and passed similar legislation. Some people refer to the state's program as the "Minnesota Model". The program effectively replaced about 10% of the state's gasoline with ethanol and built enough New Generation Farmer Coops to provide the ethanol we use.

## **Ethanol Labeling & Other Regulations**

### **27. How do we know that we are not getting more than 10% ethanol?**

It is very easy to blend exactly 10% ethanol, so it is very unlikely that it would be misblended. In order to qualify for the tax exemptions, the law says that the blend must be no more than 10% ethanol, although in some cases it may be less. The misblending of ethanol is very rare and always unintentional.

**28. Why was ethanol labeled when other gasoline components were not?**

When ethanol came into the market in the early 80's, the oil industry convinced many state legislatures that consumers needed to be warned about the presence of ethanol in gasoline because it might cause engine damage. Today, that fear has proven to be unfounded; therefore, neither the federal government nor the State of Minnesota require ethanol labeling. The Environmental Protection Agency (EPA), however, does require that oxygenates be labeled for inspection purposes where they are mandated by the Clean Air Act of 1990.

**29. What happens when the label requirement is removed?**

When the mandatory ethanol label was no longer required in Minnesota, more stations started selling ethanol, and since they didn't have to have a "warning" label many actually started to promote ethanol as a "clean air gasoline". Consumer reaction to the label removal was virtually nonexistent.

**30. Does ethanol have to meet ethanol quality specifications?**

Yes. The quality and composition of ethanol is far more consistent than that of gasoline.

## **Ethanol and Gasoline Marketing**

**31. Where does the ethanol used in Minnesota today come from?**

Minnesota now has 14 plants producing about 200,000,000 gallons of ethanol per year. One 15 million gallon plant is under construction. Minnesota should soon exceed 240,000,000 gallons of ethanol production and may become an ethanol exporting state. Since interstate trade is protected in the U.S. the ethanol you buy may or may not be produced in State.

**32. Some gasoline stations advertise "pure gasoline" what do they mean?**

The statement "pure gasoline" is a marketing ploy. Gasoline is a complex mixture of hundreds of organic hydrocarbons that are produced at a petroleum refinery. Gasoline components are not even mixed to a specific "recipe," but are blended so that the final product falls within certain specifications with the least costly ingredients available.

**33. Are the major oil companies against the use of ethanol as a fuel?**

Some are, because ethanol is domestic, renewable and a direct competitor to the imported non-renewable crude oil used to make gasoline.

**34. Are most gas station managers informed about gasoline composition?**

No, most of them are business people, concerned more with the daily problems and challenges of operating a business rather than the chemistry of gasoline.

**35. Who determines the price of gasoline at my local station?**

Every area has one or two gasoline retailers who are the "leaders" in setting prices. Other stations may follow the example of the leader. Overall, gasoline prices are impacted by such factors as supply, demand, world news, expected seasonal demand, the value of the dollar, etc. Ethanol blend prices generally follow the price of other gasolines.

**36. Where can I find a station that sells ethanol?**

All the stations in Minnesota dispense ethanol blended gasoline.

**37. Will ethanol ever be blended at levels more than 10%?**

Brazil sells a 22% ethanol blend instead of 10% as a means to extend their gasoline supplies. Blending at 22% will probably not happen in the U.S. until much more ethanol is produced, or the next crisis in the Persian Gulf drives up oil prices. While most cars produced today would operate on a 22% blend, testing by the auto manufacturers would occur before any new fuel formulation could be approved and covered under their warranties. The auto manufacturers have no incentive to pursue such an effort and the oil companies would most likely oppose it.

**38. What are potential new markets for ethanol?**

Ethanol is replacing some methanol in the windshield washing formula for automobiles and is also being used in the formulation of various household cleaners. As these products become more widespread they can help reduce the amount of toxic chemicals in domestic use. Fuel ethanol may become a common fuel for small aircraft since airplanes need a low volatility, high octane fuel to replace leaded "aviation gas". Other markets for both ethanol and the co-products from processing are sure to follow.

### **39. What is "E85" and what are "FFVs"?**

E85, a blend of 85% ethanol and only 15% petroleum, is making a splash in the fuels industry. The Twin Cities is a U.S. Department of Energy national pilot market for E85. The State of Minnesota now operates nearly 500 E85-capable sedans, minivans and pickups (known as flexible fuel vehicles or FFVs). As of fall 1999, 25,000 FFVs were registered in Minnesota with 45,000 expected by mid-2000. FFVs operate on any blend of E85 and/or gasoline and cost the same as gasoline-only models. By early 2000, 30 metro E85 fueling sites are expected with another ten sites located throughout rural Minnesota.

## **Ethanol and The Clean Air Act**

### **40. Do we have any air quality problems here in Minnesota?**

Since the 1970's the Twin Cities of Minneapolis and St. Paul had experienced regular violations of federal carbon monoxide (CO) standards until November of 1992. Since that time, ethanol has been used exclusively in this market to comply with the federal oxygenated fuel program and no further CO violations have occurred. Because of the reduced CO levels the EPA has redesignated the metro area to "CO attainment status" with the understanding that the oxy-fuel program is maintained.

### **41. How does the use of ethanol reduce exhaust emissions?**

Ethanol contains oxygen, so it contributes to a cleaner, more efficient burn of the gasoline with less CO and other toxic chemicals in the exhaust emissions. Ethanol is a simple chemical which, when burned, does not produce all the complex pollutants and aromatics formed by the many different chemicals contained in gasoline.

### **42. What is an "oxygenated" fuel?**

Any fuel that contains oxygen, and therefore does not need as much oxygen from the air to burn cleanly.

### **43. Have oxygenates cleaned the air in other cities?**

Thirty-seven U.S. cities exceeded the federal carbon monoxide standard. The Winter of 1992-93 was the first year of the oxy-fuel program required by the EPA. According to the EPA; "sites which implemented the winter oxygenated fuels program in 1992 experienced a significant sustained downward shift in ambient CO, which was not observed in areas which did not implement the program."

### **44. Will the use of ethanol help to prevent ozone pollution?**

The State of Minnesota conducted a study that showed that ethanol blends in conventional gasoline do not increase ozone. A similar study was done with reformulated gasoline in the Chicago/Milwaukee area and yielded the same results. Ethanol reduces exhaust Volatile Organic Compounds (VOC) and CO emissions from vehicles, both contributors to ozone formation. A recent report by the National Research Council (NRC) underscores the importance of reducing CO emissions to combat smog pollution. The NRC notes "as VOC emissions from mobile sources continue to decrease in the future, CO emissions might become proportionately an even greater contributor to ozone formation." Ethanol is a very effective tool for reducing CO, due to its high oxygen content, and could therefore play an even larger role in smog abatement in the future.

### **45. What is "reformulated" gasoline?**

Reformulated gasoline is a term used to describe a gasoline that results in fewer harmful emissions. The oil industry has introduced reformulated gasolines in response to pressures from state clean air regulations and the Federal Clean Air Act of 1990. Reformulated gasoline, as currently produced, reduces some of the toxic elements of gasoline that contribute to smog. EPA required reformulated gasoline to contain an oxygenate.

### **46. Do diesel engines pollute more than gasoline engines?**

Yes, diesel engines contribute to high levels of particulate (smoke) and sulfur emissions in addition to carbon monoxide, aromatic hydrocarbons and other toxic emissions.

### **47. How does ethanol affect global warming?**

Carbon dioxide (CO<sub>2</sub>) is considered the major contributor to global warming. The process of ethanol production from crop biomass grown each year results in a net reduction of carbon dioxide released per mile into the atmosphere compared to gasoline. Today most ethanol is made from corn, which like all plants "breathes" in CO<sub>2</sub> and gives off oxygen. Therefore, increased use of renewable biomass fuels will partially offset the global warming effect of burning gasoline.



**48. How long does it take for increased ethanol usage to have an impact on carbon monoxide levels?**

The results are immediate, and directly proportional to the percentage of oxygen in the fuel.

## **Ethanol and Other Gasoline Components**

**49. Does an ethanol blend burn cleaner than a premium gasoline?**

Many premium gasolines are ethanol blends. If gasoline contains oxygen it will burn cleaner than a non-ethanol gasoline. Premium gasoline is no cleaner than gasoline of a lower octane.

**50. What is the difference between ethanol and methanol?**

They are both alcohols. Ethanol is fermented alcohol, also used as beverage alcohol, made primarily from grain but may also be made from starch or sugar from potatoes, cheese whey, sugar beets or even from the cellulose in forest products or waste paper. Methanol is usually made from natural gas or coal, and is also known as "wood alcohol." Methanol is highly corrosive, more volatile than ethanol, and can be damaging to plastic and rubber fuel system components (elastomers). Because of its abundance, methanol will probably be used as a fuel in the future, but it is not as environmentally clean as ethanol, is not renewable, and is largely an imported product.

**51. What are ETBE and MTBE?**

Ethyl Tertiary Butyl Ether (ETBE) and Methyl Tertiary Butyl Ether (MTBE) are both high octane, low volatility ethers. They are made by combining alcohol with isobutylene from oil refineries. MTBE was preferred by major oil companies and has been the largest selling oxygenate in the world while ethanol is second. Recently, MTBE has received a great deal of negative publicity because of water contamination problems in areas where it is used. MTBE has been banned in California and Iowa. The future use of ether for oxygenates in gasoline is uncertain.

**52. Why don't we use fuel ethanol, instead of a 10% blend?**

Brazil was able to operate nearly half of its cars on fuel ethanol, but it would be neither necessary nor practical to do it here at this time. Most engines need modification to run on pure ethanol and cold starting would be a problem. Fortunately, a 10% level requires no engine modification, yet still makes significant immediate contributions to carbon monoxide reduction.

**53. Do we need the high-octane gasolines that the major oil companies are promoting?**

An octane number is a measure of gasoline's ability to resist pre-ignition, also known as "knocking" or "pinging." If your vehicle doesn't "ping" or "knock" or if the manufacturer doesn't specifically require a higher octane, then regular or "87" octane is all you need. A higher octane gasoline will not reduce pollution or contribute to increased power or mileage. Since fewer gallons of high octane gasoline than low octane gasoline can be made from a barrel of crude oil it is actually wasteful to use unnecessary octane.

**54. Does an ethanol blend require special handling?**

Only in special circumstances. The gasoline marketer should pump any accumulated water from the storage tank, and add a final filter to the dispensing hose before using an ethanol blend for the first time. Since seasonally used small engines such as chainsaws and outboard motors are susceptible to water contamination, it is also wise to check them for the presence of water and remove all water before adding an ethanol blend. These precautions are nothing more than good housekeeping practices, but adhering to them will assure optimum performance of an ethanol blend.

## **Corn Processing and Ethanol Production**

**55. How much ethanol can we get from one bushel of corn?**

The industry average fuel ethanol yield is over 2.5 gallons per bushel. In addition the process can yield 15-18 pounds of high protein livestock feed, 16 pounds of carbon dioxide for beverage or refrigeration use and up to 2 pounds of corn oil can be extracted from each bushel.



**56. Will increased ethanol production affect the price of soybean meal and the profitability of growing soybeans?**

Since increased ethanol production will mean increased distillers grains and gluten feed production, the initial response of the protein feed market might be lower prices. The likely farmer reaction would be to plant more corn and less soybeans. Farmers generally realize that they will benefit any time they increase their market for anything they grow. With Eastern Europe, Asia and the Former Soviet Union opening their borders and trying to upgrade their standard of living, there is great potential for increased livestock feeding and greater demand for high protein feed.

**57. What is the difference between a wet and a dry mill ethanol plant?**

The wet mill process soaks the corn kernels until the components are able to be separated mechanically. The germ is removed for corn oil, the starch is removed for industrial or food uses or converting into sweeteners, ethanol, degradable plastics, proteins, pharmaceuticals or a variety of high value consumer products. The remaining 60% protein gluten meal and 21% protein gluten feeds are sold on the protein market. A new product has recently been developed that combines with road salt to improve the effectiveness of, and reduce the corrosion resulting from its use.

The dry mill process grinds the corn to a flour and the entire product goes through the fermentation procedure where the starch is converted to ethanol. After the ethanol is distilled off, the remainder is dried and sold as a 28% protein product called Dried Distillers Grains with solubles (DDGs). There is a greater range of products that can be made in a wet mill and therefore the potential for a more stable income base than a dry mill. The cost to build and operate a wet mill plant, however is much higher.

**58. Can ethanol be made from off-grade or damaged corn?**

Yes. Depending on the nature and extent of the damage to the corn the ethanol yield may be reduced and the value of the distiller's grains may be affected. A lower price paid for the damaged corn by the ethanol processor may offset the reduced value of the end products.

**59. Can aflatoxin-contaminated or other contaminated corn be used for ethanol production?**

Yes, but there are limits on the use of the distillers grains if traces of contaminants remain. Great care should be taken to insure that a feed product made from contaminated corn is safe.

**60. Is it true that it takes more energy to produce a gallon of ethanol than is contained in that gallon?**

No, it is not true. A USDA study determined that 1.24 Btu of energy is produced for every Btu expended in the production of ethanol. This is compared with about .8 Btu of gasoline produced for every Btu expended to create it. This means that a Btu of fossil fuel used to create ethanol yields 150% more liquid fuel energy than a Btu used to produce gasoline.

**61. Can ethanol only be made from corn?**

No, ethanol can be made from products other than corn. Corn is the predominant feed stock today because of chronic corn surpluses, low prices and wide availability. Other grains, plus sugar beets, potato wastes and cheese whey are currently being used where available and competitively priced.

It is also possible to convert cellulose materials to ethanol. Cellulosic materials include grasses, trees, crop residues, wastepaper and even municipal solid waste! Cellulose to ethanol is currently too expensive to compete with corn as a feed stock but new technologies could make it a commercial reality within the next decade. This would mean not only having a greater supply of clean burning, renewable ethanol but would also reduce the volume of waste entering our landfills.

**62. What is left of the corn kernel after the ethanol is removed?**

Only the starch is removed for ethanol, so all the protein, vitamins, minerals, and fiber, and some of the energy remain. This is a very nutritious human or livestock food.

**63. How much does the corn increase in value after processing into ethanol and DDGs?**

When one processes corn to ethanol, the initial value of the corn normally doubles. A \$2.00 bushel of corn, may be processed in an ethanol plant to produce \$1.00 worth of feed and \$3.00 worth of fuel.

## **Future Ethanol Production in Minnesota**

**64. Does Minnesota government support ethanol?**

*It certainly does!* Both the Governor and the Legislature continue to support legislation that successfully expanded both the marketing and production of ethanol. Several Midwestern states have copied Minnesota's ethanol initiatives.

**65. What is the economic impact of the Minnesota ethanol industry?**

To date, Minnesota has 14 ethanol plants that will produce about 200 million gallons of ethanol. This industry will add from 350 to 550 million dollars in economic benefit to the state each year. Many support jobs were created in the trucking and service industries. An economic analysis available from Minnesota Department of Agriculture details the benefits of ethanol production to Minnesota.

**66. What is the market for ethanol in Minnesota?**

In 1998, Minnesota motorists bought 2.4 billion gallons of gasoline. If this was all 10% ethanol blend it would provide a market for 240 million gallons of ethanol, or 90 million bushels of corn.

**67. Does this mean that Minnesota farmers would increase corn production?**

Minnesota farmers normally export nearly 400 million bushels of whole, unprocessed corn per year out-of-state. Because of our northern location and heavy dependence on export markets, state farmers often receive the lowest corn prices in the nation. Continued low crop prices can lead to desperate measures, possibly planting land that would otherwise be left in sod. With an increase in the local price of corn and more profitability farmers might shift acres from another grain or forage crop rather than farm marginal land.

**68. Did it make sense to locate ethanol plants in Minnesota?**

*It certainly did!* Minnesota is at the wrong end of both the energy pipeline and the grain pipeline. We export \$1 billion of raw corn, and import over \$1 billion of liquid fuel for gasoline each year. By processing surplus corn into ethanol, we created jobs, and eliminated costly oil imports.

**69. Who owns the new ethanol plants in Minnesota?**

Twelve of fifteen ethanol plants are farmer owned cooperatives, which have 300 to several thousand individual investors each. Farmer owned New Generation Cooperatives return profits to the farmers and help maintain the economic viability of rural communities.

**70. Are dried distillers grains (DDGS) available for use by the local livestock farmers?**

Yes, they are. Any excess supplies would be shipped to other states, or exported from the U.S.

**71. If ethanol costs more to produce than gasoline, why should we promote and use it?**

There are many reasons. The market price of gasoline does not reflect any external costs, such as increased health care costs due to air pollution, the military costs of insuring access to Middle East oil fields, and the \$50 billion contribution that imported oil makes to our trade deficit. A U.S. Commerce Department analysis shows, for every billion dollars the U.S. pays for oil imports, we lose 25,000 jobs. Domestically produced ethanol adds value to grain, creates jobs and enhances our economy. If these costs were added to the retail price of gasoline, it would cost much more than ethanol.

Technology is rapidly developing to make ethanol out of cellulose. This will allow waste wood, energy crops and solid waste to be made into ethanol. It is important to create a market demand for ethanol today to drive continued research on less expensive sources of ethanol. The starch from corn could then be diverted into many more environmentally friendly industrial uses such as degradable plastics, packing materials, and pharmaceuticals.

**72. What is the future for E-85 cars?**

E85 (85% ethanol/15% petroleum gasoline) is a new, cleaner motor fuel. E85 is used in flexible fuel vehicles (FFVs) that run on any mix of gasoline and up to 85% ethanol. As of fall 1999, 25,000 FFVs were registered in Minnesota an additional 45,000 are expected by mid-2000. For model year 2000, 8 FFV pickups, sedans and minivans are available from Ford, Mazda, GM and Daimler Chrysler. More model announcements are expected in early 2000. FFVs cost no more than gasoline-only models. Marketing of E85 and FFVs will focus on the Twin Cities which has been selected as a national E85 pilot market.

The Twin Cities will have 30 E85 refueling stations by spring 2000 with 10 more located across southern Minnesota. For information, contact: Minnesota E85 Project at 1(800)642-LUNG or [www.alamn.org](http://www.alamn.org) or the Department of Commerce at (651) 297-5648.

# Storing Gasoline?

## Keep it Tightly Covered, Clean, Dry,

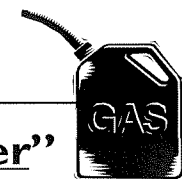
Questions have been raised about the storage of ethanol blends during the off season. The basics of gasoline storage are the same with or without ethanol. Although some gasolines may remain stable in excess of 90 days you won't know for sure without a chemical analysis of the product. Three main issues to consider in the storage of gasoline are: weathering, moisture and oxidation.

### Weathering

Weathering has to do with a gasoline's "volatility", or tendency to evaporate. Gasoline stored for long periods can lose volatile components resulting in "cold start" and "warm up" problems. If possible, provide shade to keep your storage tank cool. The volatility of the gasoline you buy changes considerably in mid September and again in early May when refiners change the recipe to improve cold weather start ups in winter and to prevent "vapor lock" in summer. Using stored gasoline purchased in fall or winter (with a vapor pressure of 14 pounds) could cause vapor lock problems on a hot spring day. Using stored summer gasoline (with a vapor pressure of 9 pounds) will make your snowmobile hard to start on a cold winter day. Ethanol blends do not change the basics of managing fuel weathering and volatility problems.

### Moisture

Moisture contamination usually is not a problem until water "phase separates" from the gasoline and falls to the bottom of the tank. Ethanol blends do not draw more water into the tank. If gasoline must be stored, be sure the container has no "water bottom" and is water tight. Keeping the tank full or sheltered from weather will minimize "breathing" and condensation on tank walls. In most tanks it would take more than a year for conventional gasoline to draw enough moisture from the air to "phase separate", much longer for ethanol blends. The most common causes of



## Cool, and use a "Fuel Stabilizer"

water contamination problems are introducing ethanol blends into a tank with a water bottom and faulty tanks or covers that allow water to flow into the fuel.

### Oxidation

Oxidation is a chemical process that reduces the octane quality of the gasoline. Oxidation can lead to sludge and acidic deposits, damage of flexible parts and hoses, sticky rings and valves, and poor carburetor or fuel injector performance. According to the Society of Automotive Engineers, "The type of hydrocarbon present in gasoline is very important in terms of storage stability or resistance to oxidation of that gasoline." Some small engine manufacturers actually use aviation gasoline for factory fill and startup since it is low in "olefins", gasoline components that oxidize easily. The new unit can then be stored until shipment without concerns of oxidation. Olefins are common in gasoline, so refiners normally use antioxidants to increase storage stability. But to protect all gasoline for several months of storage in poor conditions may not be practical. Most gasoline is stored briefly in cool underground tanks and is used in a few weeks. Moreover, the addition of too much antioxidant can cause other problems. "Fuel stabilizer" products that contain antioxidants should be used in stored gasoline according to label instructions. This, in addition to the avoidance of high temperatures, dirt and sludge deposits and copper anywhere in the fuel system, will reduce the oxidation of stored gasoline.

Storage of gasoline is part of life in our "theater of seasons". It is difficult to predict which gasolines (with or without ethanol) will store well for months at a time but paying close attention to the above mentioned issues will reduce your risk of storage problems.

If you have questions call Ralph Groschen at 651-297-2223.

# The Minnesota Ethanol Program

## Background

The 20 cent ethanol producer payment legislation initially provided the security required by lenders to risk investment the ethanol industry. In addition to opposition from the petroleum industry, bankers were concerned that relatively small ethanol plants built by farmers could not compete in the market with large agribusiness processors. Before this legislation became effective, ethanol production occurred only in large corporate mills outside the state. Minnesota corn prices were among the lowest in the country. This was bad for our farmers but might be an advantage for local processing.

Although these ventures have been successful to date, margins have been squeezed by periods of record high corn prices and low ethanol prices. It is hoped that ten years of payments will allow plants to retire debt, expand their product base and withstand the intense competition and price fluctuations of agricultural and petroleum markets. In spite of the fact that unique aspects of the ethanol industry required these incentive payments, the ethanol industry will contribute \$350 million net annual benefit to the state over and above the cost of payments made.

Since low farm commodity prices are common, these new corn plants may represent a new strategy for the long-range profitability of farmers and farm communities. Vertical integration from the bottom up could allow farmers to participate in the more profitable end of agriculture. Promoting farmer investments in the processing and marketing of other crops may not require the high level of state funding as did ethanol. But if such initiatives are successful, they could reduce the need for continual funding of farm crisis measures and allow farmers to make it on their own.

## The Main Components of the Program are:

1. The oxygenated fuel statute (MS§239.791) required statewide oxy-fuel use (10/1/97),
2. The ethanol producer incentive (MS§41A.09) provides payments for ethanol produced,

3. \$550 million in total corn/ethanol plant project spending for construction and startup costs.
  - \$370 million in private sector financing. (contingent on local equity capitol)
  - \$180 million equity capitol raised by 8,000 farmers, local businesses and towns.
  - \$260 million worth of corn committed for processing annually by local farmers.

## The Goals of the Program include:

1. To build a new market for the state's largest crop (corn).
2. To develop corn processing/ethanol production facilities in Minnesota.
3. To increase the number of New Generation Farmer Coops (NGC). (See other side of page)
4. To replace 10% of imported petroleum we use for gasoline. (\$100 million/year value)
5. To help the Twin City Area meet EPA standards for carbon monoxide.

## Results to Date:

1. 136 million bushels of corn (17% of MN. crop) can be made into ethanol and other products.
2. Minnesota's 15 plants will produce over 200 million gallons of ethanol/year.
3. Twelve of Minnesota's 15 ethanol plants are NGCs.
4. 200 million gallons (about 9%) of our gasoline is being replaced by ethanol each year.
5. The CO non-attainment standard has not been violated in the Twin Cities Since Nov. '92, when the federal oxygenated fuel program began and ethanol was used.

## Ethanol Plants & Capacities

<u>Plant location &amp; (name)</u>	<u>Capacity Million Gallons/yr</u>	<u>Million Bushel. Corn/yr</u>	<u>New Generation Co-op* Members</u>	<u>Start Up Year</u>
Marshall (MCP) **	30	12.0	4,000	1988
Morris (DENCO)	15	6.0	280	1991
Winnebago (Corn Plus)	20	8	650	1994
Winthrop (Heartland)	16	6.4	502	1995
Benson (CVEC)	19	7.2	650	1996
Claremont (Al-Corn)	17	6.8	358	1996
Bingham Lake (Ethanol2000)	15	6.0	244	1997
Buffalo Lake (MN. Energy)	12	4.8	325	1997
Melrose (Kraft)	2.6	cheese whey ..	(private)	1986
Dundas (MN Clean Fuels)	.5	cheese whey ..	(private)	1992
Preston (Pro-Corn)	16	6.4	170	1998
Luverne (Corn-er Stone)	16	6.4	201	1998
Little Falls (CMEC)	16	6.4	854	1999
Albert Lea (Exol/Agri Resources)	15	6.0	496	1999
<b>TOTAL</b>	<b>210</b>	<b>82.5</b>	<b>8,730</b>	

### Plants now under construction:

St. Paul (Minnesota Brewing)	15	6.0	(private)	1999
<b>TOTAL</b>	<b>225</b>	<b>88.4</b>	<b>8,730</b>	

\*New Generation Farmer Co-ops (NGC) are designed to:

- 1) be purchased or built by farmers to process member crops,
- 2) return more cash than crop market value and provide a return on the farmer's investment,
- 3) be controlled by farmer board members ensuring that member profits are a top priority.

\*\* MCP can also grind 48,000,000 bu. of corn for starch, sweeteners and other products. Therefore, total milling capacity in Minnesota will be 136,000,000 bu., or 17% of the state's average crop.

Processing corn products instead of exporting raw corn more than doubles the value of each bushel. In addition to fuel ethanol, corn plants produce more than 650,000 tons of high protein livestock feed plus industrial ethanol, starch, sweeteners and carbon dioxide.

## Production -vs- Market Penetration

<u>Year</u>	<u>Production</u>	<u>MN Demand</u>	<u>% MN Ethanol Produced Here</u>
FY 94*	41 mm gal.	120 mm gal.	33% of total
FY 98	121 mm gal.	180 mm gal.	67% of total
FY 99	162 mm gal.	200 mm gal.	80% of total
<b>GOAL</b>	<b>240 mm gal.</b>	<b>240 mm gal.</b>	<b>100% of total</b>

\* FY 94 = fiscal year 94 ending June 30, 1994

**NOTE: mm=one million**

# PROPERTIES OF COMMON GASOLINE COMPONENTS

	OXYGEN CONTENT	OCTANE NUMBER	BLENDING REID VAPOR PRESSURE	RENEWABLE OR FOSSIL FUEL	AUTOMOBILE WARRANTY STATEMENTS	MAX. OXYGEN CONTENT AFTER BLENDING
ETHANOL	35.00%	113.00	20 PSI	renewable	up to 10%	3.50%
METHANOL	50.00%	116.00	60 PSI	fossil	up to 5% with cosolvents•	2.50%
ETBE	15.50%	111.00	4 PSI	partially renewable	up to 17%	2.70%
MTBE	18.20%	109.00	8 PSI	fossil	up to 15%	2.70%
BUTANE	0.00%	93.00	60 PSI	fossil	limited by volatility	0.00%
BENZENE*	0.00%	97.00	3 PSI	fossil	N/A	0.00%
TOLUENE*	0.00%	102.00	1 PSI	fossil	N/A	0.00%
XYLENE*	0.00%	109.00	.3 PSI	fossil	N/A	0.00%
UNLEADED GASOLINE	0.00%	85/95	9/15 PSI	fossil	yes	0.00%

\* : Known as the BTX group of aromatics

• : Some manufacturers say to avoid methanol entirely, check your owner's manual.